Partly in consequence of this the hyoid musculature of *Rhinoderma* is closely like that of *Rana*, the omohyoid being present, which muscle has disappeared in *Breviceps*. On the other hand, the musculature of the floor of the mouth is quite specialised in *Rhinoderma*, and different from that of any other frog the anatomy of which has been described.

On the other hand, there are a few points in which *Rhinoderma* does resemble *Breviceps* and departs so far from the structure of *Rana*. The sternohyoid seems to be a double muscle in both, though the duplicity of the muscle is not so strongly marked in *Rhinoderma*. The attachment and general appearance of the iliolumbaris of *Rhinoderma* is distinctly like that of *Breviceps*. In both, the rectus internus minor of the thigh arises partly from the skin, and in neither frog is there the dorsal part of the depressor mandibulæ muscle present. In my paper upon *Breviceps* I have selected 17 characters of importance to distinguish that frog from *Rana*. It is only in four of these characters that *Rhinoderma* agrees with *Breviceps* to differ from *Rana*.

Nor are there any special points of likeness between the two genera here considered in any other features not mentioned in the list of the seventeen principal characters referred to, except, of course, such general features as both *Rhinoderma* and *Breviceps* share with *Rana*.

The divergences are most remarkable; and yet there are at least two equally remarkable points of resemblance, *i. e.* the origin of the rectus internus femoris and the absence of the dorsal part of the depressor mandibulæ. There can be no doubt, however, that, whatever may be the value of these points of resemblance, the two genera are quite as far removed from each other within the limits of family relationship as diversity of geographical position would lead us to expect. A wider knowledge of this order of animals may reveal surer bases for anatomical criteria.

6. Some Notes upon the Anatomy of *Chiromys madagascariensis*, with references to other Lemurs. By Frank E. Beddard, M.A., F.R.S., F.Z.S.

[Received May 26, 1908.]

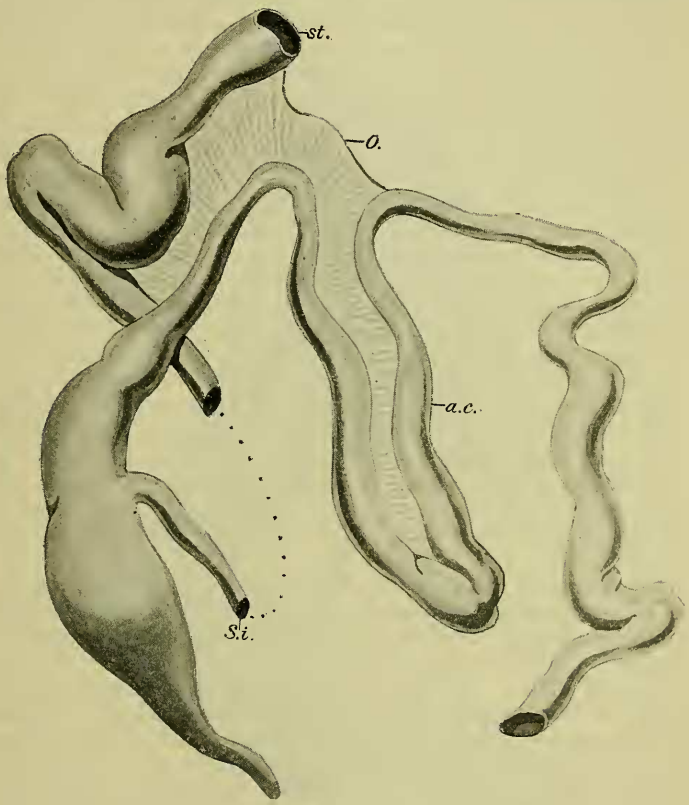
(Text-figures 150–153.)

The opportunity of examining three specimens of the Aye-Aye (*Chiromys madagascariensis*) has enabled me to add a few new facts to what is already known concerning the structure of this remarkable Lemur. The three principal Memoirs dealing with the structure of *Chiromys* are (in order of appearance) those of Owen*, Peters†, and Oudemans‡. These authors have dealt with the preceding literature relating to the animal. The

* Trans. Zool. Soc. vol. v. † Abhandl. k. Akad. Wiss. Berlin, 1865.
‡ Verh. Akad. Amst. 1890. See also Chapman, P. Ac. Philad. 1900, p. 419.

structure of the brain (with which I am not concerned here, since the specimens were sold for museum purposes which rendered the extraction of the brain inadvisable) has been quite recently dealt with by Dr. Elliot Smith*, who quotes previous memoirs.

Text-fig. 150.



A portion of intestinal tract of *Chiromys*.

a.c. Ansa coli. *O.* Edge of omentum. *S.i.* Small intestine. *st.* Opening of duodenum into stomach.

The greater part of the small intestine has been removed; the two cut ends are connected by a dotted line.

These authors have dealt at length with the external characters, osteology, visceral and muscular anatomy of *Chiromys*, and to the general descriptions given by them of the different organs I have nothing to add. There are, however, some facts, and these not altogether without importance, which have not met with much

* Cat. Mus. Roy. Coll. Surgeons, vol. ii. 1902, p. 359.

attention or have been altogether passed over by the authors mentioned, largely doubtless by reason of the apparent unimportance of those facts at the time when the memoirs in question were written. Sir Richard Owen found himself obliged to vindicate the Lemurine affinites of *Chiromys* from assertions of its Rodent affinities by comparing it definitely with *Sciurus*. Though this is no longer necessary, certain obviously Lemurine characteristics of *Chiromys* have not been sufficiently emphasised either by Owen or by his successors. With these and with some other points I propose to deal in the present communication.

Intestinal Tract.—The gut is figured by both Owen* and Oudemans†, but neither of these figures is at all satisfactory. I therefore take the present opportunity of refiguring (in text-fig. 150) a portion of the gut which shows not merely the characteristic ansa coli (flexura coli, colic loop) of *Chiromys madagascariensis*, but certain mesenteric attachments which are of importance in the morphology of the intestinal tract of mammals. Divergent in its general structure from other Lemurs though *Chiromys* may be, the intestinal tract points unmistakably to its affinity with the genera *Lemur* and *Hapalemur*, probably with the subfamily Lemurinæ. *Chiromys* possesses in fact, as do those genera‡, a single ansa coli which is a flexure of the colon shortly after its emergence from the cæcum. The two limbs of this loop were, as in *Lemur*, closely applied to each other and the loop as a whole was fully as long as—perhaps even rather longer than—the loop in the genus *Lemur*. The loop was perfectly simple and U-shaped, as is shown in the figure (text-fig. 150), and there was no approach to the spiral of the Galagininæ, Lorisinæ, and Indrisinæ.

There is some indication in Oudemans' figure of this loop; but it is not properly represented; and the various mesenteric attachments which are of importance from the point of view of a comparison with other forms are omitted altogether.

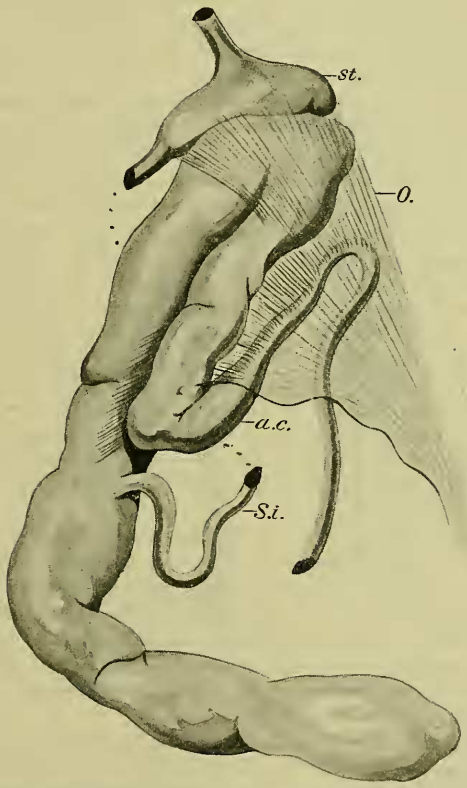
As text-figure 150 shows, the omentum is attached to the region of the colic loop where it bends to the left to become the straight portion of the transverse colon. Furthermore, as in some other Lemurs at any rate (there is not at present accurate information with regard to the simple forms *Microcebus* and *Cheirogaleus*), there is an attachment between the duodenum where it leaves the stomach and the colon where it dips down to form the proximal limb of the ansa coli. This is also shown in my figure to which I have just referred. The duodenal attachment is of limited extent, and the omentum is like that of some other forms in that it is only modified as a bridge between the stomach and the colon for a portion of the duodenal region of the former, and as already said for a very

* *Loc. cit.* pl. 26. figs. 1, 2. † *Loc. cit.* pl. iii. fig. 14.

‡ For *Lemur* see Flower (Med. Times & Gazette, 1872), Mitchell (Trans. Zool. Soc. vol. xvii.), Beddard (P. Z. S. 1908, p. 577); for *Hapalemur*, Klaatsch (Morph. Jahrb. xviii. p. 667).

limited tract of the other. In my recent memoir upon the intestine in several mammals *, I have referred to more than one species in which the attachment of the omentum to the large intestine is of the same limited extent as in *Chiromys*. But it is greater in the genus *Lemur* (see text-fig. 151) †. I may take this opportunity of remarking that the attachment of the omentum

Text-fig. 151.



A portion of the intestinal tract of *Lemur rufifrons* corresponding to that of *Chiromys* as displayed in text-fig. 150.

Lettering as in text-fig. 150.

to the colon in *Hapale penicillata* is hardly if at all greater than in *Chiromys*. I find myself therefore in disagreement with Klaatsch, who represents a more lengthy base of insertion of the omentum upon the colon (in *Hapale albicollis*).

* "On the Anatomy of *Antechinomys*, &c.," P. Z. S. 1908, p. 561.

† At any rate in *L. albifrons* and *L. rufifrons*, where it is attached all over the colic loop, and in *L. brunneus*, in which species it is attached to halfway down the loop.

It is interesting to note that, so far as the intestine is concerned, *Chiromys* comes closer to the Lemurinæ than to any of the other subfamilies of the Lemuroidea. I have pointed out that in the more specialised Lemuroidea, so far that is to say as concerns the intestine, the elsewhere characteristic carpal vibrissæ have disappeared. This conclusion will require amending since they are undoubtedly absent in *Chiromys*, a fact which my colleague Mr. Pocock observed independently of myself. Nevertheless it cannot be doubted that in other respects *Chiromys* is a specialised Lemur, so that after all the statement may still hold.

The rest of the colon is disposed in a curved course to the rectum, and there are no traces of any further ansæ coli.

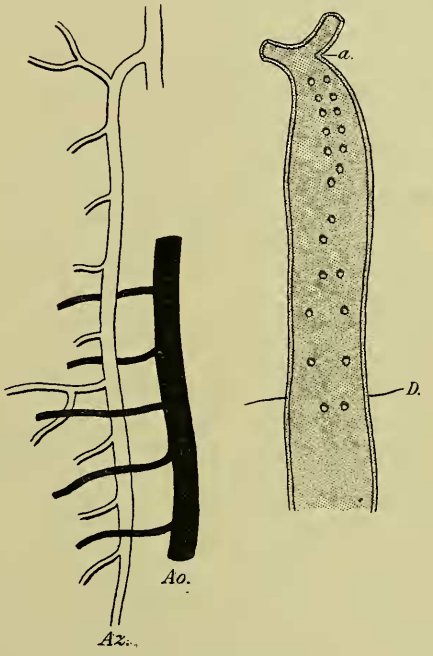
There is in *Chiromys* the usual cavo-duodenal ligament, which was not so clearly a single sheet of membrane as is generally the case. In one specimen it was single ligament of the usual type: in the two others a duodeno-renal portion could be differentiated off, attaching the end of the loop of the duodenum to the right kidney. An hepato-caval ligament was present also in the same two specimens. On the left side of the body the lieno-rectal ligament was plain, and also the lieno-renal. I may add that the right lateral lobe of the liver was attached—naturally on the right side—by a ligament to the parietes just at the origin of the dorsal part of the diaphragm. I identified this ligament in all three individuals. In an example of *Lemur brunneus* the right lateral lobe of the liver was also attached to the parietes by a ligament. I also recognised in this Lemur the hepato-caval and hepato-renal ligaments. On the left side of the body of this species of *Lemur* the lieno-renal and lieno-rectal ligaments were also very plain.

The *vascular system* has not been much dealt with by my predecessors. As is already known the aortic arch gives rise to two trunks. The intercostal arteries of mammals show some variation in their mode of origin from the aorta. Here again, however, there are not sufficient facts known to deduce any results of classificatory importance. I take this opportunity of comparing the mode of origin of these little arteries in *Chiromys* with those of some other mammals.

In *Chiromys* the first pair of intercostals arise symmetrically and very close to each other. The next four are also symmetrical but a trifle further apart. Then follow two pairs which are as displayed in the accompanying figure (text-fig. 152), the artery of the one side being much in advance upon its fellow. The remaining pairs are symmetrically paired as are the first of the series, but the distance between the orifices of each pair of arteries differs. In an example of *Pseudochirus peregrinus*, of which I cut open the aorta and examined the mouths of the intercostal arteries, they were strictly paired and quite regular. In *Hystrix cristata* I counted seven intercostals in front of the diaphragm, which however did not commence until the ninth rib. These arteries were single at their origin from the aorta.

In another specimen, however—and this is important as showing the variation of these structures—the first intercostal was single, the next two were paired but the left-hand arteriole was smaller than, and lay behind, the right. Then followed a strictly paired and equisized couple rather far apart, and after this another pair closer together. In a Beaver (*Castor canadensis*) the intercostal series commenced with a single vessel on the left side; then followed three pairs the orifices of each pair getting closer

Text-fig. 152.



Right-hand figure.—The commencement of the aorta of *Chiromys* cut open to show origin of intercostals.

a. Commencement of descending aorta. *D*. Position of diaphragm.

Left-hand figure.—Azygos (*Az*.) of *Chiromys*.

Ao. Aorta with some of intercostal branches indicated.

together, then a single median intercostal, followed by three pairs, and these again by a single median artery. After this point the artery traversed the diaphragm, and the intercostals behind the diaphragm arose singly, and were median in position. In a Chinchilla (*Chinchilla lanigera*) the first intercostal was median and unpaired. Then followed a single vessel on the right side and then two pairs. The remaining intercostals were median

and unpaired. In an example of *Dasyurus maugæi* the anterior series of intercostals were all paired at their origin excepting the last three in front of the diaphragm which arose by a single median trunk, each trunk dividing of course into the right and left intercostal of its segment. After the diaphragm the intercostals were at least chiefly paired in origin. I have figured these arteries in the genera of Carnivora *, *Helictis*, *Galictis*, and *Suricata*, where they arise as paired trunks. There exist, naturally, descriptions of these arteries in many mammals †; but there is need for further collection of facts before they can be utilised for systematic purposes, for which purposes, however, it is obvious from what has already been said that their variability will have to be taken into careful consideration. In the meantime I venture to record such facts as I have happened to ascertain myself, without attempting anything like a revision of the existing knowledge of these arteries.

I have also ascertained some facts with regard to the *venous system* of *Chiromys*, and I take this opportunity of incorporating some facts concerning the venous system of *Microcebus smithii*, of which there is apparently no published information so far as I can discover. I dissected the postcaval vein (text-fig. 153) in both of the adult specimens. It was a single vein throughout and lay as usual to the right of the aorta. The renal veins as is also usual were asymmetrical, the left lying some way behind the right. The mode of origin of the ovarian veins varies somewhat in mammals. In *Chiromys* the vein supplying the right side arose from the postcaval not far in front of the posterior bifurcation of the latter. The left vein, on the other hand, arose from the left renal, as is often the case. This particular asymmetry is very general in mammals, but it is not always the case that the right ovarian vein flows into the postcaval so far down. In the male specimen there was an interesting difference in the place of influx of the two spermatic veins. That of the right side corresponded on the whole with the right ovarian vein. But that of the left side did not arise from the left renal vein but from the postcaval behind that vein, though some way in front of the point of origin of the right spermatic vein. The homologue of the ovarian vein of the female was, however, also present on the left side. The renal vein, in fact, received a branch at a point exactly corresponding with the entrance of the left ovarian vein in the female example. But this vein ended in the muscular parietes and was evidently concerned alone with the venous system of the lumbar parietes. These facts are illustrated in the accompanying text-figure.

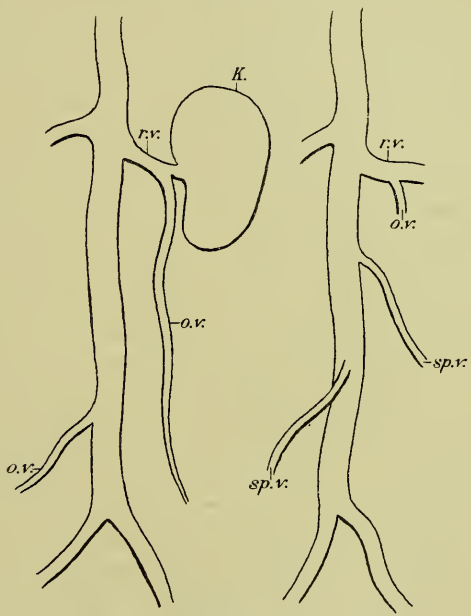
In *Microcebus* the arrangement of the corresponding veins was

* "On the Anatomy of *Helictis personata*," P. Z. S. 1905, vol. ii. pp. 27, 28, text-figs. 11, 12.

† *E. g.* in *Ornithorhynchus*, Manners-Smith, P. Z. S. 1894, p. 714; Manatee, Murie, Trans. Zool. Soc. vol. viii. pl. 26, fig. 44; Horse, Chauveau & Arloing, Traité d'Anat. Comp. Anim. domest. 1871, f. 555, and many special treatises.

somewhat different. In the specimen which I dissected the right renal vein, which poured its contents into the postcaval headward of the left renal, was formed by two trunks which, however, united before entering the postcaval. This may well be a mere variation. But it is worthy of note that double renal veins particularly on the right side are very usual among Armadillos. It is also very general in *Tragulus**. And here, again, it is on the right side that the anomaly occurs.

Text-fig. 153.



Postcaval vein of *Chiromys*, the right-hand figure of a male, the left of a female.

K. Kidney. *o.v.* Ovarian vein. *r.v.* Renal vein. *sp.v.* Spermatic vein.

The primitive nature of this little Lemur was also shown by the mode of connection of the ovarian veins with the postcaval. There was no such asymmetry as has been described in *Chiromys*, and which is so general among mammals. The veins in question are opposite to each other not far from the posterior bifurcation of the single postcaval. On the left side the vein was more complex than on the right side. It divided at once into three vessels. This, however, is not the only peculiarity of these veins in *Microcebus*. From each renal vein a slender vessel ran backwards parallel with the postcaval trunk, and in the case of that

* McClure, Anat. Anz. Bd. xxix. 1906, p. 375; Beddard, Am. Journ. Anat. 1907, p. 112.

of the left side poured its contents into the ovarian vein at its origin. I did not succeed in tracing the corresponding vein of the right side all the way; but in any case it commenced anteriorly in exactly the same way as the other vein. It will be noted, therefore, that the conditions obtaining in *Chiromys* could be arrived at by an obliteration of the connection of the ovarian vein of the left side with the postcaval, and the retention only of its embouchure into the renal.

I may observe that in an example of *Galago garnetti* the origin of the ovarian veins was quite as in *Chiromys*. On the other hand, in a male of *Nycticebus tardigradus*, the arrangement was slightly different from, though not in great disagreement with, *Chiromys* and *Galago*. In *Nycticebus* in fact the left spermatic vein poured its contents into the left renal. The right, on the other hand, opened into the postcaval, though very near to the point of origin of the here more or less symmetrically arising renal veins.

The *internal mammary veins* of *Chiromys* run one on each side and in association with the artery at some distance from the middle line of the sternum. The two veins are connected with each branch of the single precaval vein where it bifurcates at the front end of the thoracic cavity. This is quite the normal arrangement for these veins, but I mention the facts since there are sometimes differences. For example, in *Lutra vulgaris* I found the internal mammary a single vein on the right side, but with several branches supplying the left side of the middle ventral line. Moreover, it is also desirable to note that each of these veins runs closely accompanied by its artery strictly parallel to the middle line of the sternum but at some distance from it.

The azygos vein is not figured by previous investigators of the anatomy of *Chiromys*. I have examined this vein (text-fig. 152) in each of the three specimens which I dissected, and most carefully in the last example which was a young female. It is developed only upon the right side of the body, as in all Lemurs hitherto studied. It is a well developed vein and extends backward to nearly the diaphragm. The first branch supplies two intercostal spaces, and the last branch of the series but two is also divided in the same way. There was no trace that I could discover of any corresponding vein upon the left side, neither was there a hemiazygos. The point at which the intercostal arteries pass outside of the azygos vein is a matter which varies much among mammals. But the material does not as yet exist for a use of the facts for systematic purposes. It is, however, obviously permissible to state the conditions observed in *Chiromys* with a view to future generalisations. I found, in fact, that in this Lemur the first of the series of intercostal arteries to cross over the azygos vein, as viewed in the ordinary position of dissection, was that lying behind the tenth rib. Thereafter all the intercostal arteries had the same position. In front of this point they underlay the vein.